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Plastics

Dealing with the Manufacture, Uses and Potentialities of Plastic Materials

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Natural v. Synthetic Rubber

SOME four or five years ago, when the wonder of synthetic rubber and rubber-like compounds first burst upon the world with heavy journalistic force, we remember visiting Manchester in order to listen to a famous chemist tell us of one of these " rubbers " and what it was hoped to produce from it. He told us why it was an improvement on natural rubber, but he added, it was to be a new material to help natural rubber and not to compete with it or oust it. The synthetic variety would merely enter those fields which the natural substance could not satisfy. We do not believe he was talking with his tongue in his cheek, but he proceeded to give a long list of applications for the new materials, ranging from boots and aprons to gaskets and gloves, from tubing and printing rollers to stoppers and ball valves, all of which have for years and years been made of natural rubber. The lecturer's argument would be that the synthetic rubber boot or what not would be used in the oil industry where the natural rubber boot would not be good enough, but this argument would not hold much water since the synthetic rubber boot by good salesmanship could be made to enter any industry in direct competition with the rubber variety even though the latter were cheaper.

Many of us, quite without a bias for either material except a natural scientific one for the man-produced improved type, saw the red light for natural rubber and, indeed, foresaw an ever-growing attempt to improve on the quality of the natural material in order to narrow the discrepancy. We do not know how far this discrepancy can be removed and, indeed, we believe that Dr. Schidrowitz, the famous rubber chemist, once said that it could not be, but it would seem that even in this country, the home, so to speak, of natural rubber, the only things that will not be made of synthetic rubber will be motor tyres. We are, of course, speaking of some future, although not necessarily distant, date. Theoretically, even the tyre of natural rubber may disappear.

The only thing that holds up the wider use of synthetic rubber is its price and its small production—small, that is, compared with the production of natural rubber. Synthesis is a costly business, but the cost will tend to decrease steadily as new methods are discovered and as bigger plants are installed. On the other hand, there seems little concrete evidence that the price of the natural rubber can go much lower. Indeed, if certain promises of social reform are made good after the war, there will be a tendency to a rise in wages for native labour. One might hope, for natural rubber is a very wonderful thing, in spite of synthetic rubber, that the botanists could have been able to grow new varieties to give greater yields or to make the trees come to maturity in much shorter time. Judged from a purely scientific point of view, the scales seem to be weighted heavily in favour of a material that can be produced so much more rapidly than another—a small factory in Manchester or in Akron, Ohio, can manufacture in unit time hundreds or even thousands of times the weight of material that a forest of equal size in the F.M.S. produces.

As for the future, it is difficult to foresee how the growing struggle between the two substances will result. On general principles it is the better substance, in this case synthetic rubber, that must oust the inferior one, in spite of price, and, as civilization improves, this change will be hastened. Unless, of course, the botanist, or, rather, the "genetician"-botanist, has something remarkable up his sleeve which can change the natural rubber molecule to conform more closely to the synthetic one.

The Designer in War-time

THE British plastics industry has in the past two years been through such a gruelling time with its problems of rationing of raw materials—plastics or steel for moulds—lack of designers or tool-makers, restriction of new designs, restriction of production, to say nothing of those due to the gentle dropping of bombs in the vicinity, that the moulder is apt to regard the similar troubles that are now arising in other countries, with a humour that is somewhat grim. However, whilst we are not exactly in smooth waters, yet such difficulties abroad receive our sympathetic understanding.

The United States of America is now undergoing similar worries and it will be important to us that she gets over them as rapidly and as smoothly as

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she can. What these difficulties are, are plain to some workers in the U.S.A., where they have learned, perhaps, a little from our own. At any rate, in a recent issue of "Durez News," an ably run little magazine published by Durez Plastics and Chemicals, Inc., there are some wise generalizations and warnings by W. O'Neil. Some of them should be noted by industrialists in this country who are changing over from metals to plastics.

With the grim spectre of war breathing heavily over the designers' board, says the writer, we find a complete reversal of the situation of 1930 (when design and style made sales easy) with production methods, materials and man-power dominating the scene.

Obviously the industrial designer-stylist-sales engineer can make no contribution to war-making goods that has not already been made and as far as the consumer market is concerned this, for a long time to come, will be affected by Government priorities on materials, man-power and the Government itself as a major consumer.

Every battleship, army camp, Government bureau, construction corps, creates a huge market, from paper clips, saucepans, to practically every item that goes into the home, farm or business office. Such huge demands that a market like this creates will by its priority leave little for the ordinary family.

This means to the American manufacturer that demand is increasingly greater than the supply and that every facility he possesses must be directed towards turning his products out and not thinking up ways to charm his market because his market, under certain patriotic intoxication, will be forced to accept what the manufacturer can give him and like it.

Already some manufacturers, faced with the dearth of tool-makers, are considering reverting to some of the cast-iron efforts of the past. Others are checking their dies with the thought of reviving some obsolete models; still others are considering, for the first time, the adoption of plastics to take the place of die castings.

From a designer's point of view, this last is a logical, progressive step, and will force the designer into greater comprehension of this medium which, with better understanding coupled with salesmindedness, will open up greater opportunities for design expression than ever.

From a manufacturer's point of view, the idea of converting his product from one material into another calls for changes that may radically affect the appearance of his product. It is not a simple matter to change over from zinc die casting to plastics, wood or glass without taking into consideration the differences in thicknesses that these new materials require. Again, there may be the matter of reinforcement.

This is where the manufacturer needs expert advice from the designer, as the problem is entirely different than starting from scratch, and requires a more careful approach from the standpoint of design. The advantage to the manufacturer lies in the fact that the average industrial designer is acquainted with the uses and limits of many materials and can adapt these readily to meet specific problems.

Once again, the industrial designer can show his effectiveness in this situation of defence priorities, and leaders in the manufacturing field are starting to recognize this. On the other hand, the designer should be fully acquainted with defence activities and priority ratings of materials.

In this critical period of uncertain futures, the responsibility that will rest heavily on the designer's shoulders will be that of making his client fully conscious of product development so that the product will be abreast of the market when defence activities lessen.

If the designer is as sales-minded as he should be, he will be making surveys in the field of his client's activities to determine the effect of current economic changes on the buying attitude of his market as well as encroachments into his client's market by smaller organizations who have not been affected by the Government orders.

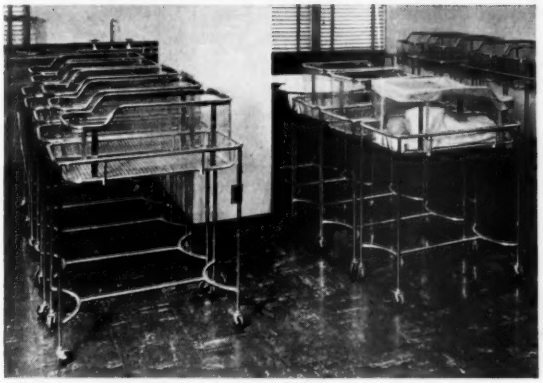
The Royal Coach

As an adjunct to the preceding notes, one of the most interesting problems is the situation, created by present conditions, in the baby-carriage industry. Doubtless Hitler and his generals consider this industry second in importance only to the actual battle, for cannon-fodder must be available for their next war. Doubtless, too, the German baby-carriage made entirely of plastics is being manufactured.

In this country the Government has ordered that the quantity of metal in the baby-carriage be cut down from 40 lb. to 14 lb. This means a radical alteration in design of certain components, and a wider adoption of non-metallic materials. The more obvious suggestions are extruded plastic rods or tubes for handles and axles and plastic wheels of new design. The adoption of resin-impregnated laminated bodies is already in sight. There is, in any case, an excellent opportunity here for the designer.

Silly Ideas

At the recent gathering of members of the Institute of the Plastics Industry, we were cornered by a friend privileged to tell us these things, who said what a daft idea such and such was. He was referring to one of our suggestions on our Ideas page as being quite incapable of moulding by the method we suggested. As he is one of the most brilliant of engineers in the game, there was no doubt he was right, and we apologized profusely. He insisted that this journal should give correct information regarding all things or not at all. We thought that occasionally it did not matter much. After all, as most readers know by now, the Editor of this journal is not endowed with all knowledge and is not a mechanical engineer. He merely possesses some chemical knowledge of plastics, some experience of their limitations, what can be made from them, and some idea of what the outside world wants. The moulding industry does not expect, nor does it ask for, ideas to be handed to it on a silver plate, that is with blue-print drawings. It realizes, as does our friend in lucid moments, that production of almost anything in this world necessitates a co-operation of workers to the one end, hence the need of chemist, designer, mould-maker, salesman and others, the greatest of these being any of them according to your taste. It might be delicately suggested, therefore, that new ideas regarding design or method of production should be avoided. With this we disagree for many reasons, two of which are that such methods are provocative of argument and that there is little harm in silliness now and again. The main function, anyway, of these ideas—and some are purported to be humorous at times and many are merely ideas cribbed from outside sources—is to get the moulding industry to think on broad lines—a consummation devoutly to be desired—and to introduce a trace of lightness into what is often a weighty branch of human endeavour. If the Ideas page succeeds in doing this it will have served a useful purpose.



Cellulose acetate basinettes in a modern crèche.

Typical plastic housing for a sterilizing apparatus.

Plastics Still an Out-patient in the Modern Hospital

Of all the Institutions for the helping of Mankind the most likely foster-parent of the Plastics Industry should be the Hospital. In a world where decay of body and mind are fought, it might be reasoned that the clean, non-perishing, colourful and transparent qualities of Plastics would find welcome consideration. Their adoption, on a large scale, however, is not extensive

WHY should plastics be of particular interest to the medical, surgical, nursing and administrative sides of the modern hospital? It is useful to answer in some detail this self-appointed question, and to do so bearing in mind the very special requirements of all four branches of the organization.

1. Properly selected plastics possess a surface which can, with the minimum of ease and expenditure on cleaning materials, be kept scrupulously clean and aseptic. Where it is desired to sterilize the surface, some of the latest types of plastics enable this to be done without risk of injury to the material itself. Cold sterilization, now extensively adopted in many hospitals in preference to the use of boiling water, has no injurious effect on plastic materials. Such compounds as alcohol, liquor cresolis compositus, chloroform and albolene, hydrogen peroxide, mercury compounds, formaldehyde in alcohol, etc., will not stain or corrode those materials specially chosen for the purpose. Then, again, absorption of moisture, once a serious fault of certain plastics and the main reason why they proved unsuitable for specialized applications, is now overcome by the introduction of new types, particularly melamine and polystyrene. The former has an advantage over the latter in being able to withstand high temperatures without injury. Another point of primary interest is that the physical structure of the plastic surface, with its complete freedom from pores and crevices, etc., is an additional safeguard, as the potentialities of infection due to dirt are much reduced. Melamine was so highly thought of in Germany that small bath tubs were made from it.

2. Plastics are light in weight, non-inflammable, structurally strong when properly designed and readily adaptable for a wide range of purposes. For instance, two main fields can be catered for: Actual furnishings, such as wall panelling and flooring, and equipment which includes special surgical accessories utilized in operations.

3. Colour and utility can be combined with very happy results. The importance of this can be appreciated by all who have spent any appreciable time in a hospital. The psychological effect of bright, cheerful colours on child patients is very noticeable and plastic pieces of equipment, which normally appear somewhat terrifying in metal, lose a lot of their grimness.

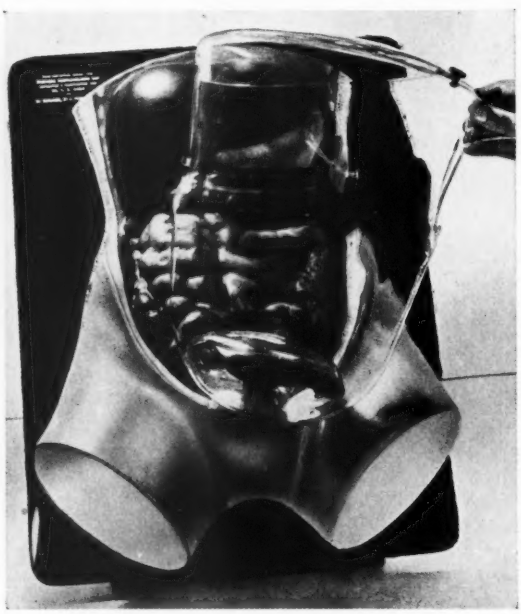
4. The peculiar physical properties of the acrylic resins, such as the flow of light round curved surfaces, coupled with their amazing transparency, offer material advantages over metal and ceramics. Added to this is the fact that thermo-plastics may be fabricated, that is with the greatest of ease, and there is frequently no difficulty in making experimental pieces of equipment for the surgeon to try out.

5. One subsidiary property of plastics which should be of interest to doctors is that the surface is never cold to the touch, so that there is no chance of cold shock to the patient.

Plastics for General Furnishings (Walls and Floors)

Turning from the general introduction or summary of advantages to particular applications, the first and most obvious is the use of plastics for wall coverings and for floors. The main advantages of using laminated sheets for the panelling of hospital wards are well known, because they have so often been stressed in this and other journals. It is true that architects are mildly interested in this application, but price kills the job. They point out, and with a great deal of truth, that most hospitals, and particularly the voluntary ones, are built on the principle that so many beds have to be found for the minimum outlay, and in consequence the cheapest materials and the simplest designs are the order of the day. It is easy, therefore, to appreciate the reason why, at present at all events, plastic panelling is not being used for covering the walls of the main wards.

In the case of the walls of operation theatres, X-ray rooms and other highly specialized departments, a strong case can be made out for plastics, as expense is not considered to the same extent. For operating theatres in particular, the use of laminated-sheet wall coverings offers two great advantages, namely, considerable, if not total, reduction in condensation, and the ease with which the temperature of the room can be retained at the desired optimum, due to the excellent heat-insulating properties of the material. In addition, the walls can be washed down with antiseptic solution and kept in an aseptic condition with ease and speed. This factor alone relieves the theatre sister of a great deal of anxiety.



Cellulose acetate sheeting plays an important rôle in this anatomical model.

The floor of the operating theatre and X-ray room is usually made of rubber, but plastics might well be considered as alternative materials. The latest vinyl resins are able to stand up to extremely hard conditions of service without in any way being affected either physically or chemically.

(To evaluate the sanitary qualities of the plastic surface is a comparatively simple matter. All that is necessary is for the hospital bacteriologist to make a count of the micro-organisms recovered by swabbing a definite area of the wall to be tested. The count can then be compared with that obtained by swabbing a similar area of another wall surface under approximately similar conditions. Such a test gives results in practical terms and shows what claims can be justified for the special product.)

Furniture and Special Equipment

There is little doubt that in this highly specialized field the greatest opportunities are offered to plastics. Already, of course, plastics are being used, particularly in America, but as yet only the merest fringe of this new field of development has been touched. Here are a few of the possible future applications: At present most of the hospital trolleys carrying sterile dressings, surgical spirit, ether, etc., for pre- and post-operational treatments have highly polished, stainless-steel surfaces, which are usually cleaned every morning by rubbing down with surgical spirit and ether. Whilst no one would dispute the general serviceability of the steel top, it is as well to point out that it is expensive and occasionally does become stained owing to the use of special drugs. Plastic sheeting, particularly the new melamine material, which is completely non-water absorbent, offers great possibilities. It is available in white, ivory and a wide selection of colours, is economical to purchase, easy to keep aseptic, never cold to the touch and light in weight. Moreover, it renders the trolley a less formidable piece of equipment and so more acceptable to child patients, who are so easily frightened.

Another likely use for plastics, again with melamine in view, is trays, sputum bowls and all kinds of smaller hospital accessories. There seems, indeed, no reason why urine bottles, and even bed pans, should not be moulded of plastics. They would be considerably lighter in weight than those now in general use made of ceramics, warmer to the touch and very much cheaper to purchase. In the case of bed pans, however, it is as well to point out that there is a need for the utensil to be sterilized by steam, and nurses often leave the pans in the sterilizer for a long time. Possibly this difficulty could be overcome.

Acrylic resins, cellulose acetate and other transparent plastics, such as polystyrene, have received more attention from hospital equipment manufacturers and furnishers than any other materials. Considerable publicity has been given to depressors and other surgical instruments fabricated of methylmethracylate resin, such as Perspex, Lucite, Plexiglas, and these are already proving their worth in both American and European hospitals. They owe their value to the innate ability of the material to transmit light around curves, so that it comes out bright and cold at the end. The tip of the instrument is illuminated by a magnifying-lens bulb in the handle.

Transparent Models

Information has just come to hand regarding the use of transparent cellulose acetate and vinyl resin for anatomical models intended for demonstration purposes in hospitals and medical schools. The latest example is the Rubin Uterotubal Insufflation Test model, which is entirely made of plastics illuminated from the rear. Translucent cellulose acetate, painted, forms the back section, which includes the liver, stomach, colon, small intestines, and the front section is made of transparent vinyl-resin sheet stock, which forms a container for a liquid used in the medical demonstration. Lightweight

and portable, the model is practically unbreakable and more realistic than those made of moulded rubber or papier maché. This model, undoubtedly the forerunner of many other types, was developed for Dr. I. C. Rubin, well-known American gynæcologist, to demonstrate the Rubin Uterotubal Insufflation Test, a method of determining whether the fallopian tubes are open or obstructed. It is used in lectures and demonstrations before various medical associations and was first described in "Modern Plastics," July, 1941. Doubtless this will be the forerunner of many demonstration units utilizing transparency.

Suggested New Application

An application which the writer has discussed with specialists in this country, and appears to be not without some promise, is associated with the new method of treating burns with saline solutions. The latest method consists of allowing a saline solution to flow gently over the injured skin surface for a prescribed period. Special apparatus is needed for this treatment, which will enable the saline to flow continually round and over the burn and be drained off. In the case of burns on the arm, for instance, rubber sleeves have been developed which can retain the saline flowing from a small reservoir fixed above the patient's bed and allow it to drain off some distance below the injury by means of an outlet tube. Whilst this method is undoubtedly satisfactory, it has at least one rather serious disadvantage, namely, that the rubber, being opaque, prevents regular medical inspection of the wound during treatment, such inspection demanding the complete dismantling of the apparatus. To overcome the disadvantage of the rubber sleeve, one made of organic glass would appear to offer the ideal solution, combining complete inertness to the saline with high non-absorbent properties and maximum transparency, and good heat-insulating properties. Limb covers fabricated of these materials would, in addition, be very light in weight and easy to keep clean, both during and after use. Unlike rubber, these plastics are completely odourless.

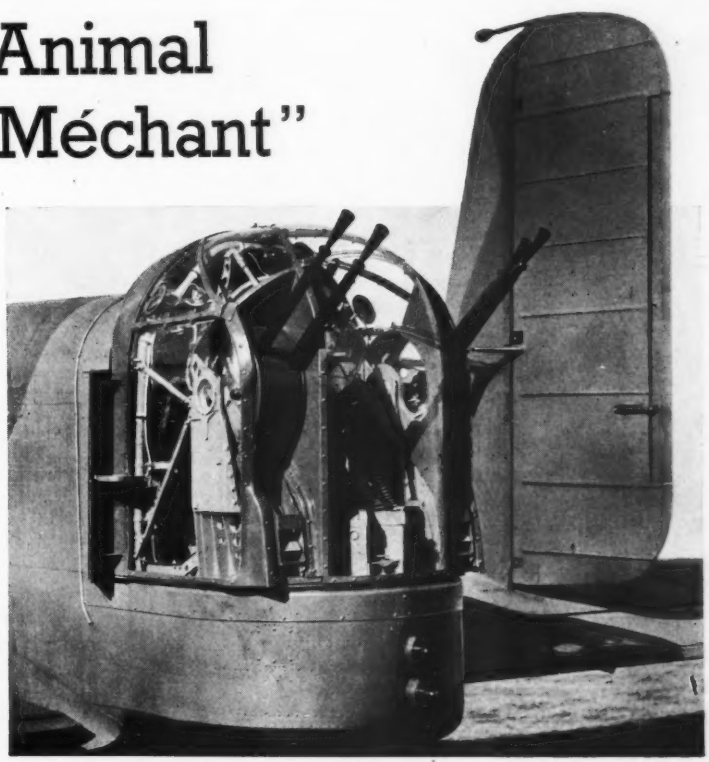
Polystyrene resin is now being used in America for hospital drinking glasses and for other small vessels. This resin is chosen for the purpose on account of its great resistance to water and ability to withstand frequent washings in warm, soapy solution without structural changes in the material. The delicate, translucent colouring of the material is also of very great attraction in the children's wards of the hospital. Indeed, the importance of colour may assume large proportions.

Of considerable interest, too, from the point of view of child hygiene is the report ("Plastics," February, 1941) that basinettes have been constructed of cellulose acetate. In large crêches visibility of the individual children is important, and cleanliness and ease of cleaning of the bed a most desirable adjunct.

Plastics are also being used for housings of various types required for specialized hospital equipment, a good example being the American "Sterimatic" device which automatically provides a sterilizer solution for cleansing glasses and other utensils. The sterilizing agents are compactly arranged and completely concealed behind an ivory "Plaskon" covering, which is simply designed and easily kept clean.

Before concluding it is as well to remind readers that the latest type of plastic, namely, nylon, is already being used for sutures (wound thread) and appears to give satisfaction. This protein-like material, which has a density of 1.14 and a tensile strength of 5 grm. per denier dry and 4.4 grm. per denier wet, is said to be superior to many of the well-known sutures in use.

"Cet Animal est Très Méchant"



The sting in the tail of a Whitley bomber. The transparent turret is shaped from Perspex (methyl methacrylate resin).

"Quand on l'attaque il se défend"

Melamine Synthetic Resins

These new resins, which are now being made in this country for use in enamels, are also most promising raw materials for general moulding

MOST stories of industrial chemistry are the stories of the production of what were hitherto rare chemicals costing pounds per ounce, on such large scales and by such new methods that the rarity becomes a common chemical at pence or shillings per pound.

The plastics section of the chemical industry is no exception to the rule, the classical example being urea, which was first made synthetically 113 years ago. Up to the beginning of the 20th century there was no industrial use for the material at all and was available to the academic world only in very small quantities. When its value as a fertilizer was discovered its manufacture increased enormously. Then towards the end of the first quarter of this century urea-formaldehyde resins took the field, and manufacture of urea jumped up still further and prices dropped to new low levels.

The story of melamine is just as spectacular. It was first isolated by Liebig as long ago as 1836, but even until a few years ago it was available only as a rare chemical, almost a laboratory curiosity, costing 10s. per ounce. To-day it is available in ton lots at about 3s. per lb.

The ultimate raw material is that compound of many uses calcium carbide, which is first converted to calcium cyanamide (a material composed of calcium, carbon and nitrogen) by heating carbide with nitrogen gas obtained from the air. Calcium cyanamide, which usually appears on the market as a blackish powder, is an extremely useful material used in the production of some pharmaceutical products, as a fertilizer (it evolves ammonia on mixing with water), and for the hardening of steel. For the manufacture of melamine it is first converted into dicyandiamide, a greyish-white powder. This dicyandiamide (a compound containing carbon, nitrogen and hydrogen) is also used in some countries as a fertilizer, and is converted into melamine by heating under pressure with liquid ammonia, the latter being recovered and returned to the cycle of operations. The foregoing method is that usually adopted on the Continent, but a new patented process, developed in this country by British Industrial Plastics, Ltd., avoids the need for expensive high-pressure plant, and moreover succeeds in obtaining a yield of 90 per cent. of the theoretical results.

Melamine is a white crystalline compound melting at 354 degrees C., and may be considered as being a polymer of cyanamide; cyanamide is $CN.NH_2$ and melamine is $(CN.NH_2)_3$.

This melamine by heating with formaldehyde results in the production of a synthetic resin, water white and soluble in water and alcohol, with remarkable properties and applications in three different fields:

(1) As a resin for the paint and varnish industry.

(2) As an impregnant for wood and glue for veneers for the production of strong, water-resistant laminated sheets.

(3) As a new moulding powder.

1. Melamine Resin as a Resin for Enamels and Varnishes

The following notes regarding this application have been forwarded to us by Beetle Products Co., Ltd., division of British Industrial Plastics, Ltd., and relate more especially to those stoving lacquers and enamels made from drying oils and resins, which have replaced in many spheres the original vitreous enamels and metal plating. In this section the outstanding applications are in the production of road signs, automobile finishes, switchboards, refrigerators, electric irons, etc.

Melamine resins have the following important characteristics:—

a. **Speed of Hardening at High Temperatures.**—Melamine resins are the fastest hardening thermo-setting resins on the market. Just as alkyd (glycerine phthalic anhydride) resins were far surpassed in speed of hardening by urea resins, so the latter are outclassed in this direction by melamine resins. Finishes based on these resins become extremely hard after stoving for a few minutes at 250-300 degrees F.

b. **Colour and Gloss Retention During Baking.**—Before the advent of melamine resins, high-gloss stoving enamels, especially whites, were extremely difficult to formulate. Either the enamels were based on alkyd resins alone and became yellow on baking, or were formulated on mixtures of alkyd and urea resins, in which case colour retention was good, but gloss retention uncertain. High-temperature stoving does not affect the gloss and colour of enamels based on melamine resins.

c. **Low-temperature Baking.**—With urea-alkyd resin finishes a stoving temperature of at least 250 degrees F. is required in order to obtain first-class results, especially as regards water resistance, and in consequence water-jacketed or steam-heated ovens giving temperatures of about 200 degrees F. cannot be used. But the introduction of lacquers and enamels based on melamine resins now makes possible the use of these low-temperature ovens as the finishes can be baked at temperatures of 180-200 degrees F.

d. **Outdoor Durability.**—Melamine resins have extremely good weathering properties, and may be used to speed up and improve the hardness of alkyd resin finishes without impairing the water resistance and durability.

e. **Compatibility With Alkyd Resins.**—Melamine resins are completely compatible with both non-drying oil and drying oil modified alkyd resins, and may therefore be used in proportions varying from 5-100 per cent. of the latter. Even with the use of small amounts (10-20 per cent.) of melamine resin in an alkyd finish the stoving time can often be cut down by as much as 50 per cent.

f. **Compatibility With Drying Oil Varnishes.**—Melamine resins are compatible with oleo-resinous varnishes such as linseed-oil copal varnishes, and may be used even in small amounts to increase the hardness and the speed of baking of these finishes. Their use in this new field offers great possibilities.

g. **Compatibility With Nitrocellulose and Ethyl Cellulose.**—Melamine resins are completely compatible with nitrocellulose and with ethyl cellulose up to 40 per cent. of the latter.

h. **Electrical Properties.**—The insulating and non-tracking properties of melamine resins are excellent.

2. Melamine Resins for Laminated Material

Melamine resin appears to have been adopted as an impregnant for wood veneers and the production therefrom of consolidated laminated sheets, in Germany and more recently in U.S.A. (Beetle Products Division of American Cyanamid Co., New York). In solution melamine resin can be used as the principal bonding material or on the surface sheets when other resins have been used as the main bond. The water-whiteness of the resin permits of perfect retention of colour of the original wood.

Already the Westinghouse refrigerator is fitted with a melamine laminated door panel, while the production of decorative panels, table-tops for bar-counters and general equipment in stores, restaurants, bathrooms where colour and sanitary appearance is desirable, is strongly recommended.

3. Melamine Resin as Moulding Powder

With the appearance on the market of the new melamine moulding powder is fulfilled the long-standing wish of industry for a bright-coloured plastic which may be worked without special moulds and without specially high temperatures. In addition the cured resin possesses special properties of great value which assure it immediately of very wide fields of application. Melamine resin is supplied in the form of a fine powder and should be stored in a cool, dry place in well-closed containers, in order that its flow properties may be maintained for a long period. It should be noted that production of the moulding powder appears to be confined, for the present, to Germany.

As with other synthetic resins hardened steel dies are required, but owing to the fact that the moulding powder is neutral they need not be made of corrosion-resisting steel, nor need they be chromium plated. The mean moulding pressures should be about 4,000 lb. per sq. in. Curing temperatures cover the wide range from 130-165 degrees C., the optimum values both for temperature and time, particularly in the case of components possessing varying sections, being best determined by experiment on test pieces in the usual way. Prolonged over-curing is to be avoided on account of its unfavourable effect upon the mechanical properties.

In working up the new resin, the various devices found of value in connection with urea and thiourea resins may be applied without modification. Thus, in the case of tooled thin-walled objects, such as beakers, cups, etc., it is recommended that the powder after filling the mould be warmed for 20-30 mins. at 90-100 degrees C. The loose powder " concentrates " by this heating and assists in more complete homogeneous flow during pressing.

Flat objects, such as plates and so on, may be moulded quite satisfactorily without prewarming, if the mould be allowed to stand for about 10 secs. after closing.

Moulded objects from melamine resin are characterized by their high resistance to the effect of dry heat, hot water and hot beverages, such as coffee and tea, and are usually free from all taste and smell. On account of its high resistance to tracking, melamine resin is particularly valuable in connection with high-tension current work as on insulating material for conductors.

Chemically, melamine resin has more resistance than the urea resins against weak acids and alkalis, and is also very resistant to organic solvents. In the preparation of mouldings for holding foodstuffs, the resin is particularly to be commended, as it does not react with fruit juices, acetic and citric acids, mustard, fats and oils.

Suggested Mouldings in Melamine Resin

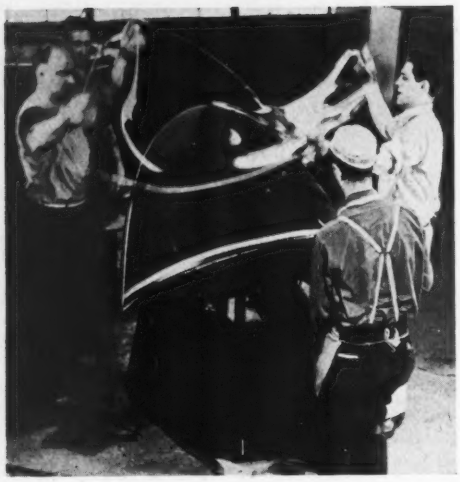
At the March, 1939, Leipzig fair the melamine resin, known in Germany under the trade name of Ultrapas, was shown at the stand of Venditor. Mouldings made from it, in the form of beakers, cups and saucers, balls (billiard balls?), etc., were exceptionally beautiful. In view of the high water resistance of the finished mouldings, the resin has been suggested for the manufacture of an interesting range of domestic utensils. They are shown in the accompanying picture, which formed part of a pamphlet issued by Venditor. As will be seen, the utensils are a bath-tub (presumably for children), a soap-dish, a bath-spray nozzle and a developing tank for photographic work. It will be noted that all the objects portrayed are more or less in continual contact with water or solutions of soap or chemicals in water.

The following data on melamine resin are those for Ultrapas:—

Specific gravity of moulding	1.5-1.6
Tensile strength ...	6,700 lb./sq. in.
Bending strength ...	12,000 lb./sq. in.
Compressive strength ..	30,000 lb./sq. in.
Water absorption (7 days)	2 mg./100 cm.^{2}
Internal resistance, direct	10^3-10^4 meg. ohms.
Surface resistance, direct	10^4-5 by 10^4 meg. ohms.

Melamine resins enter new fields of production.

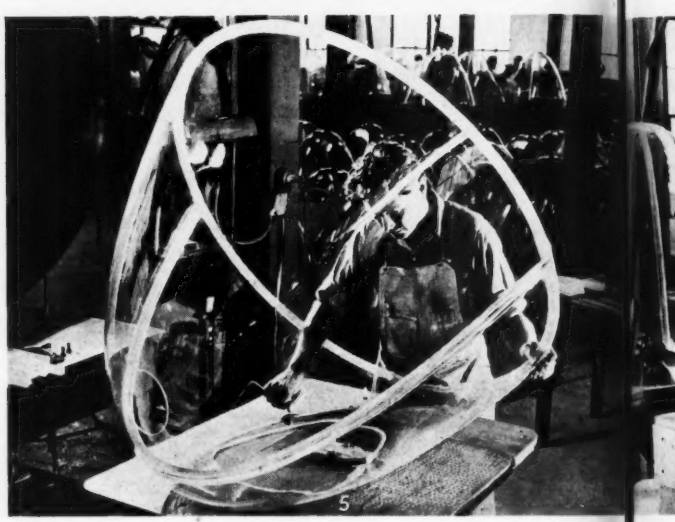
C



(Left) Laying a sheet of Plexiglas, which has been heated to 200° F., over a form which is to give it the required shape.

(Right) Hand clamps fasten the edges of the sheet to the form.

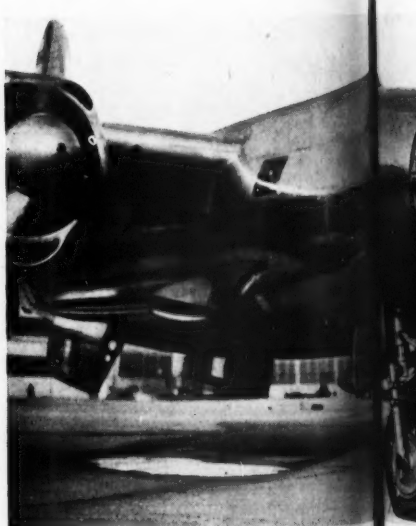
Need for transparency reaches its maximum in modern air warfare where bomb-aimer and gunner must possess a wide and clear view——



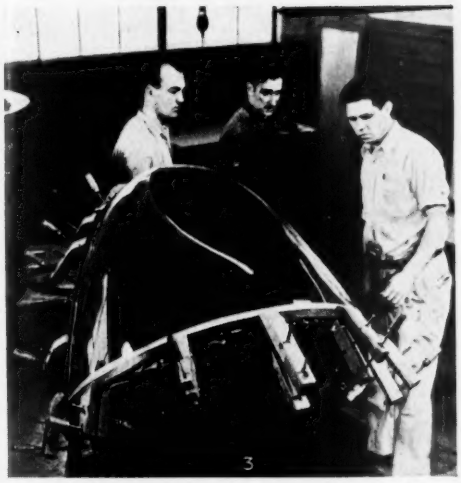
How Bomber Noses Are Pl

IT is well known, of course, that the crystal-clear acrylic resins in sheet form have been widely employed in making noses, gun turrets and cockpit enclosures for aircraft, but not until recently have particulars and photographs showing steps in their production been released for publication. The great clarity of the acrylic plastics and their ability to withstand weathering, as well as ease in forming to the required shape, are primary considerations in their choice for such applications. Accompanying illustrations show several steps in the production of noses for one of the United States Army's newest and most advanced medium bombers, known as the "Martin B-26." The material employed is the acrylic-sheet material known as Plexiglas, produced by the Rohm and Haas Co. and fabricated at their plant in Bristol, Pa. The same material, which weighs less than half as much as glass, is, of course, much less fragile and much easier to form to required contours and to machine, and is employed for similar purposes on all types of fighting 'planes.

The first step in production of bomber noses is to heat the sheet plastic to 200 degrees F., after which workmen, using gloves, "drape" the sheet, which the heating has softened, over male forms so as to give it the shape required. Two men handle the sheet, and when it is in place over the form two other men assist the first two to clamp the edges of the sheet to the form, using screw-operated wood clamps, such as workers in wood employ. Clamping is done rapidly, before the sheet can cool and harden. As the sheet cools over the form it is forced to retain the shape of the form, although no press is



Close view of the Martin B-26 bomber, showing the nose fastened in place. Similar enclosures are used for the tail gunner, the navigator's hatch and tail enpennage and four side windows are also Plexiglas.



(Left) Sheet clamped over the form is left to cool and harden and retain the shape of the form. A portion is subsequently cut away to form a door.

(Right) Trimming away flash, where the clamping was done, by means of a band-saw.

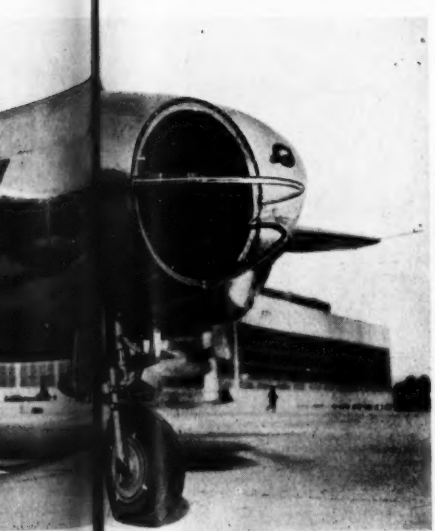
——Modern organic glasses, as typified here, provide these advantages and also avoid the danger from splinters that real glass would bring

e Ficed From Organic Glass

required to give it this shape. Several forms are provided, and while one sheet cools others are clamped to other forms by the crew experienced in such work. It is important to avoid flaws, specks and distortion, as they interfere with true vision through the sheet and with the aiming of guns, which project through the shell when in service.

When the sheet has cooled to the shape of the form it is removed and transferred to a band-saw, where flash or irregularities at the periphery, where the clamping was done, is cut away. Because of the size of the half-shell, two men handle it, and one sees that it is correctly guided against the saw, which is similar to or identical with saws used in wood-working. After proper trimming the two halves of a shell are cemented together, employing the same acrylic resin from which the sheets are made originally.

Subsequent to cementing and drying thereof, the shell is delivered to a machine for cutting holes for the gun mount and for the shaped bomb-door. Edges of holes are then carefully trimmed and routed to fit the mating metal parts which are bolted in place subsequently. Although great care is exercised to avoid scratching the plastic, handling may result in slight blemishes and in fingermarks, which are removed by using a soft buff mounted at the end of a flexible shaft to facilitate moving the wheel over the surface of the assembly as it rests on a bench. Some hand wiping is done also, especially on interior surfaces, after which the nose is ready for packing and shipment to the aircraft assembly factory.



This machine is reported to be faster than many pursuit 'planes even when carrying its full load, including 2½ tons of bombs, fuel, and a crew of five men. The flying range is also exceptionally large.

The War of Metals

With the change-over to war-weapon production the U.S.A. is urging the wider use of non-metallic raw materials. The table below is indicative of one method of publicity. While our change-over is already complete, yet there is a need, for the guidance of industry, of tables showing where plastics can replace metals

A RECENT pamphlet issued by Dun and Bradstreet, Inc., of New York, is entitled "The War of Metals" —a survey, by Walter Mitchell. It is a timely production for the U.S.A., although it affects Great Britain but little, since we have almost got over our teething troubles in introducing plastics for metals where plastics are either an improvement or where metal cannot be used because of obvious shortage and restrictions.

With the United States undergoing an intense change in production from peace to war-time weapons, there seems little doubt that that country will also have to change radically the raw materials for many of her industries. The plastics industry in that country, as, of course, in our island, has the chance of a lifetime.

"The War of Metals" attempts to survey the crucial situation that has arisen, and points out that little will be gained if one metal is replaced by another which, in its turn, is also a "critical" metal. Obviously, industrialists must be prepared to replace, wherever possible, metals by non-metallic substances, and industrialists, designers and scientists are urged to combine their knowledge and resources to this end. If only examination of the whole problem be swift, many of the demands of civilian life could be supplied as before, without the need for stringent curtailment such as exists in Great Britain. The U.S.A., with its vast population and great resources in raw materials, such as phenol, urea, formaldehyde, acetylene, cellulose, etc., is in a much more favoured situation than any other country.

The survey gives a table which includes some finished goods that have already been successfully replaced by plastics. While it is woefully small for our real interest, for every reader could multiply the examples a hundredfold, yet these are probably given merely as examples. It seems a pity that under "Construction" nothing plastic is indicated and that "Aircraft" is not mentioned at all.

The table is, nevertheless, a pointer to the future place of plastics in world affairs, and is, of course, presented for examination to the executives of industry. As such it is of value in publicizing plastics to industrialists.

Type of Product	Former Material	Substitute Material	Cost After Change
REFRIGERATOR			
Ice cube trays	aluminium	tinned copper; steel	higher
Door handles	zinc die casting	injection plastic	same
Interior fronts	aluminium stamping	steel, cadmium plate	same
Trim on humidifier	aluminium	plastic	lower
Thermo housing	aluminium	stainless steel; plastic	lower
Evaporator	stainless steel	tinned copper; enamel on steel	higher
Hydrator	enamelled steel	pliofilm zipper envelope	—
RANGES AND HEATERS			
Gas burner head	aluminium die casting	cast iron	lower
Vent grill	aluminium casting	steel stamping	lower
Kerosene tank	zinc	glass	—
Range and heater trim	chromium or nickel steel	plastic	—
OTHER HOUSEHOLD EQUIPMENT			
Cooking utensils	aluminium	enamel on steel	higher
Kitchen cabinets	steel	wood	—
Dinette table tops	steel	laminated resin impregnated wood	—
Cutlery	nickel silver	discontinued	—
Fly screens	bronze	plastic	—
Washing machine agitator	aluminium	plastic	lower
Washing machine clutch handle	zinc die casting	plastic	—
Vacuum cleaner dome	aluminium die casting	injection plastic	lower
SMALL TOOLS			
Lathe face plates	aluminium	cast iron	higher
Electric tools—handles	aluminium	plastic	lower
Saw guard	zinc die casting	plastic	—
FARM EQUIPMENT			
Wire and fence	galvanized steel	"Corronized" steel	—
CONSTRUCTION			
Rigid electrical conduit	galvanized steel	black-enamel on steel	—
AUTOMOBILE BODY PARTS	steel	soy bean fibre laminated plastic	—
SPORTS			
Boat whistle	chromium plated brass	plastic	lower
Skeet trap	aluminium casting	cast iron	lower
Ski pole rings	aluminium rod	rattan	same
Camera case	aluminium casting	plastic	lower
Film spool	aluminium	plastic	lower
Thermos bottle top	aluminium	plastic	same
Bicycle frame	steel	laminated plastic plywood	—

Ideas—

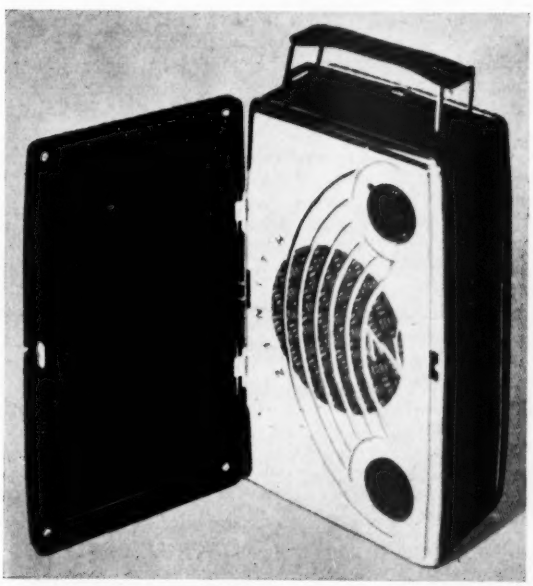
By the EDITOR

Plastic Draining Boards

There is one piece of apparatus in a laboratory I occasionally work in that I have long wanted to see made in plastics of some kind. It is the draining board, a simple structure of wooden base and pegs on which are hung beakers and flasks to dry after washing. The wooden pegs are merely plugged into holes in the base. There are two disadvantages in existing draining boards. One is that the wood rots, the peg bases quickest, and the second is that the fragile beaker sometimes breaks during moments of heavy-handedness by impact with the wooden peg. What I should like to see is the wooden base made, if not of laminated plastics, at least of ordinary wood lightly impregnated with water-resisting resin, and the pegs of extruded rubber, neoprene or polyvinyl chloride, that is, rigid enough to support the beaker and not sag, and sufficiently rubbery not to break the glass. Generally there is no question of alkalinity or acidity, since the beakers and flasks are cleaned out with plenty of water. In oil laboratories, however, they are often cleaned with benzene, white spirit, etc., so that it might be advisable to stick to the peg made from oil-resisting rubber-like plastics and not natural rubber. This would cover all requirements and might even be applied to domestic use. The pegs could, of course, be easily moulded of phenolic or urea resins, or of acetate, but I think elasticity is essential.

Smaller and Smaller

If things proceed at the present pace in radio design and building we shall soon have radio cabinets small enough to fit into our vest pockets and be disguised as watches, powder puffs or matchboxes. The newest of the baby-portables to be found on the American market is the Zenith Poketradio just released by Zenith Radio Corporation, Chicago. In design this newly announced receiver is strikingly similar to the ordinary small folding camera; the precision workmanship and performance of the radio are similarly fine.



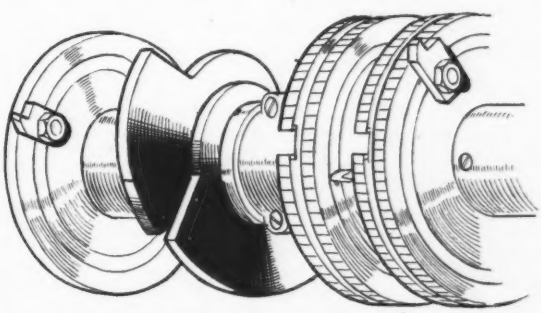
The case is attractively made in Bakelite, leather and japanned metal, measures but $3\frac{3}{8}$ inches by $4\frac{1}{4}$ inches by $7\frac{5}{16}$ inches. A highly efficient 4-tube superheterodyne chassis is used. Complete with batteries, this new portable weighs only four pounds, nine ounces.

The inside cover of this new Zenith—designed with product name over a background etched to simulate leather—is moulded of Bakelite Polystyrene by Chicago Molded Products Corp., as are the knobs moulded of Tenite I. Both parts were injection moulded.

Not only does the polystyrene inside cover provide an attractive finishing appearance for the baby portable, but it serves as a factor in assuring perfect operation of Zenith's sensitive Wavemagnet, a device that eliminates the need for aerial and ground attachments to the radio. The plastic materials in the case cover, by eliminating surrounding metal that would hamper reception, offer complete protection to both radio and Wavemagnet, and at the same time provide a trouble-free, interference-free housing for the mechanism. Plastics, indeed, are being utilized more and more because of their valuable properties and not merely as pretty-pretty materials.

Laminated Cam Blanks

It is always extremely satisfying to read of some new adoption of plastics in a heavy industry, such as modern engineering. This is easily explained, since it is this sphere that has been concerned in practice and in thought with metals as almost the only possible materials of construction. Any non-metallic substance that does secure a foothold in this field does so in the face of strong conservative opposition, as the result of long tests and because it is eminently suited for the job. In a very important sense, therefore, the entry of plastics into industry raises their status considerably.



In the accompanying drawing (taken from "English Mechanics," June 27) the cam, shaded dark, is cut out of laminated resin-impregnated sheet. It is part of an automatic screwing machine, where its strength, resistance to oils and other fluids make it ideal for the job.

One of the great advantages of the resin sheet is the ease with which shapes can be punched from it.

World's Industrial

AIRCRAFT

Nose of the new Martin B-26 bomber is in Plexiglas. Assembled from two half-paraboloid pressings joined with an acrylic-resin adhesive, the nose is the most striking of a range of parts on this craft, formed from transparent plastic, including rear-gunner's turret, tail empennage, navigator's hatch and side windows. **Cold and hot setting glue for aircraft construction** manufactured under the name "Plaskon" by the Plaskon Co., Inc., Ohio, has been authorized for general use in aeroplane construction by Civil Aeronautics Authority in U.S.A. Hitherto, permits for such uses have been limited to the application of the glue to specific parts of the craft. **Laminated wood components** designed for operation under heavy loads require stringent testing. Riechers, in a past issue of "Holz," notes that centrifugal force in an airscrew rotating at 2,000 r.p.m. may be equivalent to a tensile load of 35 metric tons per blade. For tensile tests, specimens 250 mm. long by 4 mm. wide are cut from the sheet to be used for the airscrew. A typical figure for the unnotched material is 2,700 kg./sq. cm.; the effect of a notch may be to reduce this to 2,200 kg./sq. cm. Shear strength varies from 200 to 400 kg./sq. cm. Modulus of elasticity averages 250,000 kg./sq. cm. The exposure of the specimens for a few moments to hot water suffices to determine whether or not the resin glue has been sufficiently cured. The strength of the joint between any two adjacent layers may vary between 120-180 kg./sq. cm. for ordinary grades, to 350 kg./sq. cm. for specially toughened woods.

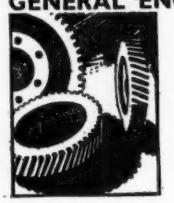
ELECTRICAL

Flashlamp batteries manufactured by General Duralite are marketed in a transparent Tenite pack, the cap of which incorporates a moulded lens (also in Tenite) mounted in an opaque shell. **Ozonizers of high efficiency** and more readily controllable than those of old type have been marketed by the Ozo-Ray Corp. The generator is of the metal-plastic-metal type, the dielectric used consisting of a specially modified phenol-formaldehyde resin approximating in electrical properties to rubber hydrochloride, to which, however, it is technically superior and more economical. The characteristics of the discharge across the resin are such as to yield an ozone remarkably low in oxides of nitrogen and, apparently, of greatly reduced toxicity, to human beings and to bacteria. **Electrically operated hand tools,** driven by small, highly stressed motors, and possessing relatively low bulk, tend rapidly to heat up in use. Ehlers, in a past issue of "Kunststoffe," cites such plant as electric drills and hot-air blowers as typical instances, where, quite apart from the greater measure of safety conferred by the use of non-conductors, the thermal insulating properties of plastics may be turned to advantage in the fabrication of casings and grips. This aspect is linked up with that of much smaller electric household apparatus, the operating conditions of which differ markedly from that of larger industrial plant. **Household articles built up** from semi-fabricated plastic, or plastic and metallic forms, are also touched upon by the same author, with special attention to the fact that many plastics may satisfactorily be assembled by means of adhesives, provided the design chosen be such as to give adequate surface for guaranteeing firm adhesion.

BUILDING

Colour stability is likely to prove an important factor influencing continual growth in the popularity of plastic fixtures and ornaments in architectural work. A dissertation presented by Schäfer before the convention of Darmstadt Technische Hochschule dealt at some length with the determination of light fastness of transparent plastic bases. Various light sources were employed and it was shown that the most powerful influence was exerted by ultra-violet radiation, although even the visible blue was capable of effecting marked colour changes. The ordinary filament lamp showed far less pronounced effects. Of the resins themselves, urea resins proved most resistant to change, whilst phenol-formaldehyde resins proved most sensitive. Changes appear to be associated with increased absorption of the shorter wave length, hence the acquirement of a yellow or brownish hue. **Weather-proof and vermin-proof board** for the exterior surfacing of houses, made by bonding three plies of wood with cresol-formaldehyde resin is the subject of U.S.P. 2,232,075. **Fire-retardant** paints based on dicyandiamide-formaldehyde and urea-acetaldehyde resins have been investigated by Van Keek at Forest Products Laboratory, Madison, Wis. These resins produce very voluminous chars on heating, and it is to this characteristic that fire-damping properties are due. Efforts might be made, it is suggested, to determine whether even better resins might not be found within this group.

GENERAL ENGINEERING



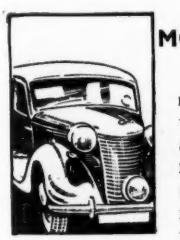
Elastic moduli determined by special dynamic testing apparatus are presented for a number of better-known plastics in a recent account by Kurt Fröhlich. At 20 degrees C. typical figures are as follow:—Impregnated paper, 1,440 kg./sq. mm.; Pollopas, 1,000 kg./sq. mm.; "Vulcanfibre," 650 kg./sq. mm.; Trolit, 625 kg./sq. mm.; Plexiglas (M222), 500 kg./sq. mm.; Plexiglas (M132), 425 kg./ sq. mm.; a cast resin, 400 kg./sq. mm.; Astralon, Mipolam, and a polystyrene resin, 350 kg./sq. mm.; hard rubber, 300 kg./sq. mm.; celluloid, 275 kg./sq. mm.; cellulose acetate (Cellon), 225 kg./sq. mm. The modulus/temperature curves for these specimens are of interest. Between 15 and 30 degrees C. the modulus decreases practically linearly by a figure of almost 15 kg./sq. mm. for the total temperature increase, for every specimen, excepting Trolit, which drops sharply from 800 to 500 kg./sq. mm., with a distinct break in the curve at 23 degrees C., the cast resin, which drops sharply at 23 degrees C. to a value just in excess of 350 kg./sq. mm. at 28 degrees C., and the resin-impregnated paper, which gives an ascending curve flattening out to the horizontal at 23 degrees C. The figures given here are rationalized from the author's curves. **Cutting of laminated materials on a paper base** was discussed by H. Ferchland in a dissertation before the Technische Hochschule, Dresden. Circular saws, especially those in low-alloy steel, are quickly blunted by laminated sheet (paper base) above 20 mm. thick. Hand feeding tends to cause seizing, but, in any case, it is not as a rule possible to avoid the produc-

...mploys Plastics

tion of dust and fumes when sawing plastics with circular saws. Mechanically fed saws are best operated at 15 metres/sec. or over, with a feed equivalent to the removal of 20-60 sq. cm./min. For hand-fed saws, a speed of 30-60 metres/sec. is advised, according to material thickness. **Safety guard for presses** and similar types of machinery is constructed of methylmethacrylate plastic and weighs about 1.5 lb. instead of the 3 lb. metal-and-glass guard formerly used. It has been put into use at the G.E.C. lamp factory at Nela Park, Cleveland, Ohio. **To assist metal consumers in U.S.A. during the present critical period,** when the use of aluminium, magnesium and zinc is restricted largely for defence purposes, Monsanto Chemical Co. have circularized metal users as to the possibility of their using plastics in place of the metals they have had to forgo. The concern is also increasing its production of Lustron and Resinox plastics for moulded jobs.

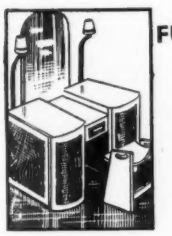
TEXTILES

Leatherette continuously overwound with a Tenite spiral is used for a new belt which has recently appeared amongst women's fashions in U.S.A. It is smooth, cool and light, and is available in a range of attractive colours. **Woven handbags** in Tenite are also gaining popularity on account of their hard-wearing properties and dirt-resisting finish. White suede-texture Vinyon gloves have also made their appearance.



MOTORS

Brake linings of metal wool bonded with Buna are, according to German authorities, superior to those of normal composition containing asbestos. The metal (iron or aluminium) in the form of fibres not greater than 0.03 mm. in thickness must be so incorporated in the mass that each fibre is completely surrounded by the rubber. The wear resistance of the mass is high, and its frictional properties are said not to be affected by water, or by oil or grease. Furthermore, the coefficient of friction appears to be independent of normal temperature rises. Linings have also been made of metal wool bonded with plastics containing specially adapted plasticizers. **American Autoclub emblems** in Tenite have proved to withstand well constant exposure to extremes of temperature and humidity and to resist the abrasive action of wind-swept dusts from the roadway. Plastics and Diecast Products Corp. is responsible for the moulding of these signs.



FURNITURE

New cold-setting adhesive based on urea-formaldehyde resin has been developed by the Resinous Products and Chemical Co., Philadelphia. It is known as "Uformite B.555," and is recommended when hot pressing or curing processes are considered impracticable in plywood manufacture or in assembling wooden components. **Stapling machine** by the Ace Fastener Corp. incorporates a top, or handle, moulded in Eastman Tenite, and is available in green, red, walnut and black to match predominant decorative scheme in the office.

CHEMICAL

Spotlight on the suitability of plastic bearings for certain branches of chemical engineering is provided by Graebing in a past issue of "Rundschau. dtsch. Techn." The account presented deals with the use of such bearings in the highly abrasive environment obtaining in the mining of brown coal, where the steel bearings formerly used had not only to be of special design, but, in addition, required frequent renewal. Bearings in moulded "T_2" and in a laminated plastic "F," were found to give a life of up to 5,000 hours under most strenuous conditions of loading, often with very irregular application of lubricants, consisting sometimes of grease or oil, and, in one instance, of water, the bearing so treated giving 9,000 hours' continuous service. **"Dupor No. 1" dust respirator,** manufactured by H. S. Cover, South Bend, Indiana, has been reduced in weight to well below 1 oz. by replacing aluminium valves by moulded plastic valves. In view of the frequent corrosion by condensation of metallic valves and diaphragms used for purposes such as this, it is suggested that the possibilities of plastics be still further explored in this direction.

MISCELLANEOUS

New general-purpose phenolic moulding compound available under the name "Durez 775 Black" is said by manufacturers, Durez Plastics and Chemicals, Inc., to be stable to heat up to 220 degrees C., to possess low water absorption capacity, and to have greater tensile and bending strength than the common run of resins of this group. It is, furthermore, fast moulding and curing, and takes a high-polish finish. **Defence requirements in U.S.A.** have hastened the creation of new plant for the production of Thiokol by the Thiokol Corp., and the Dow Chemical Co. A new works was recently opened at Midland, Mich. The new unit is said to have a capacity of 70 tons a month, whilst final total production is projected at over 2,500 tons per year. **Beryllium-bronze moulds** are sponsored by Gadeau in a past issue of "Mat. Plast. Synthet." Particularly in the case of the thermosetting resins, the high heat conductivity of beryllium bronze (four times that of steel) tends to facilitate increased output. The author also refers to the inertness of many aluminium alloys and of unalloyed aluminium itself to attack by the organic constituents of many plastics. Extrusion apparatus may advantageously be made of heat-treated beryllium bronzes, which possess the strength of steel with a very high degree of corrosion resistance. **Solubility of nitrocellulose** in acetone/benzene was investigated by Inone, Nakazawa and Kimura, and reported in "Transactions of the Cellulose Institute," Tokyo (February, 1940). With nitrogen contents in the order of 13 per cent., solubility is regular and increases with increasing temperature. For nitrogen contents below this figure solubility increases rapidly with rising temperature, whilst, for higher nitrogen contents, solubility tends to decrease under like conditions. This investigation forms part of a major research into the chemistry of cellulose undertaken by the authors.

Inquiries and Answers

(In Which is Included General Correspondence)

IMPORTANT NOTICE: If inquirers wish to receive replies by post, a stamped and addressed envelope must be included in their letter. It is understood that the submission of a problem to the Editor permits its publication in this journal.

Laminated Racks for Buses

We are very interested in the application of plastic fittings and panels to passenger-carrying vehicles and enclose herewith a page out of "Bus and Coach" referring to the use of plastic panels as lining material for parcel racks.

Can you give us any further information about this material, or is a similar material available in England and, if so, who makes it?

Loughborough. WILLOWBROOK, LTD.

[EDITOR'S NOTE.—The racks referred to above are made by gluing two sheets of vulcanized fibre to a veneer, presumably of wood, by means of Tego film under pressure. The technique seems to be the same as that used for making plywood with the exception that the curvature of the finished material is introduced. Two panels form a luggage rack and at the same time act as a conduit for the air conditioning plant of the coach in which it is fitted. The lower panel is punched with $\frac{1}{8}$-in. holes for the airflow.

The use of vulcanized fibre, while novel, introduces no difficulties to normal technique. The application of laminated plywood for similar purposes has already been discussed in this country and will, no doubt, go ahead after the war. Gluing, or impregnation, may be carried out with phenolic or urea solutions as well as with glue films.

The following concerns can be approached for help on the subject: Bakelite, Ltd., British Industrial Plastics, Ltd., British Plywood Manufacturers, Ltd., Thos. De La Rue and Co., Ltd., Micanite and Insulators Co., Ltd., New Insulation Co., Ltd.]

Resins for Water Softening

We have noted in your issue of July, 1941, reference to the use of synthetic resins for water softening. The information contained in this article is correct, but we would draw your attention to the fact that the name of United Water Softeners, Ltd., was changed some time ago to The Permutit Co., Ltd., and we would very much appreciate a correction to this effect in your next issue if you can find it convenient.

London, W. THE PERMUTIT CO., LTD.

Book on Plastics for the Home Workshop

I am a handicraft teacher, now serving in the R.A.F. Prior to joining the R.A.F. I was experimenting with the use of such plastics as Catalin Perspex and Erinoid in my work. I found the materials very suitable for handicraft work in school, and the boys were able to make some interesting and beautiful articles. I intend, when peace returns, and I return to my job, to make much fuller use of plastics. Meanwhile I should like to read any books which are on the market dealing with plastics from the point of view of the amateur or school worker.

I do not think that there is an English book on the subject, but I am told that there is an American book dealing with work in plastics for amateurs. I should appreciate it if you could tell me the title and price of this book and where I could obtain it. Details of any other books which you think might help me would also be welcome. P.W.B.

Bristol.

[EDITOR'S NOTE.—The only book of this type we know is "Plastics in the School and Home Workshop," by A. J. Lockrey, published by D. Van Nostrand Co., Inc., New York. We do not believe, however, because of money exchange problems, that the book can be obtained from America. At some future date it will be published in this country by Chapman and Hall, Ltd., London, who may have American copies for sale. We also have a copy in this office which the inquirer may see. It is undoubtedly most suitable for the work described.]

Velan, Waterproofing Agent

We noticed a reference in a recent issue of the journal "Plastics" to a water-proofing agent named Velan and we are wondering whether you could give us any further information regarding this product, as water-proofing materials are of interest to us.

If you cannot give us any details, perhaps you could inform us who might be able to supply the information.

Any particulars you might be able to forward to us would be treated confidentially.

Purfleet. THAMES BOARD MILLS, LTD.

[EDITOR'S NOTE.—Velan is a complicated organic compound, a quinoline or pyridine derivative, we believe, manufactured by Imperial Chemical Industries, Ltd. It is highly water repellent, acting in a manner very different from the so-called waterproofing materials, the efficacy of which usually depends on the closing of the interstices between fibres. Velan is absorbed by the fibre leaving the interstices free. It is widely employed for the treatment of dress and coat fabrics.]

Transparent Valves for Demonstration

We have designed and patented a new type of interconnected valve on our Trailer Fire Fighters which is a very great step forward in simplifying the operation of fire engines, which you will appreciate is a highly desirable requirement in view of the harassing conditions under which firemen have to work in war-time.

The underlying principle of this valve is extremely simple, and yet, as so often happens, it is most difficult to illustrate it adequately. We therefore feel that its working principle would be very much easier to understand if we could have a number of valves made in plastic material, the outside body part of the valve being transparent, with the inner part of the valve being made in a coloured plastic which would show how the various parts line up and achieve the inter-connection.

We feel that 100 of these models distributed to the chief fire brigades of the country would do more than

anything else we can think of to familiarize firemen with the way this system works.

Can you kindly recommend us to any firm who would undertake the making of these valves for us?

COVENTRY CLIMAX ENGINES, LTD.

Stratford-on-Avon.

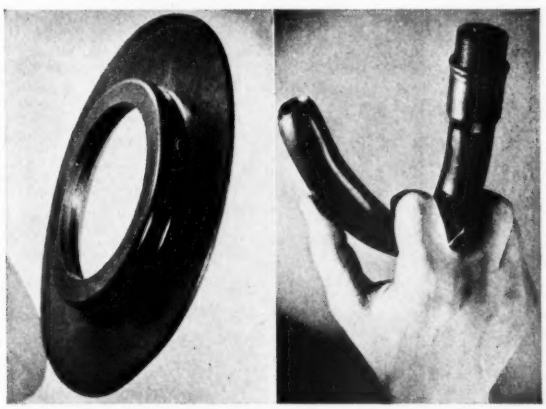
[EDITOR'S NOTE.—Without examination of the valve itself it is difficult to advise, but we presume that the only methods would be the use of cast phenolic resin rods or tubes, of cast methyl. methacrylate rods or tubes, or of cellulose acetate sheeting or tubes. Advice might be obtained from Catalin, Ltd., I.C.I. (Plastics), Ltd., or BX (Plastics), Ltd., who could supply names of fabricators of objects made from the above transparent plastics by turning, drilling, etc.]

Mouldable Synthetic Rubber

Some years ago you mentioned that Thiokol synthetic "rubber" could be moulded from a powder form of the material. We should be glad to know if this is correct and where we could get samples. E.J.K.

Blackburn.

[EDITOR'S NOTE.—Thiokol is available in both sheet and powder form and some years ago we received from the Thiokol Corporation, Yardville, New Jersey, a small solid ball used, if we remember rightly, as a ball valve in an oil pump of the air-lift type. The ball had been moulded



from powdered Thiokol. Actually it is in the form of small granules. We have had the accompanying photograph in this office for some considerable time. Both objects have been moulded from the powder. Thiokol is available in a wide range to make soft or hard objects.]

King Aircraft Corporation

My attention has been drawn to a paragraph in the current issue of *Plastics* on my future activities.

It was very kind of you to insert the paragraph, but unfortunately the contents are rather inaccurate and have caused a certain amount of "heart burning" in certain directions.

It is true that I have resigned from Aeroplastics, Ltd., and have no further connection with the company and that I have formed the King Aircraft Corporation, which will be manufacturing and, I hope, selling the King-Comfort Pilot Seat for bomber aircraft, but the seat contains no plastic material in its manufacture and is, in fact, principally constructed from armour plating.

I do not know whether it will be asking too much for you to run a correction paragraph in your next issue. J. MCEWAN KING.

London, E.C.

Resin-impregnated Papers

Further to our answer to inquirers regarding manufacturers of resin-impregnated papers, our old friend Mr. H. E. Mabey, resin development manager of British Resin Products, Ltd., informs us that his company should not have been included in the list. It manufactures only synthetic resins of the phenol-formaldehyde and polystyrene type.

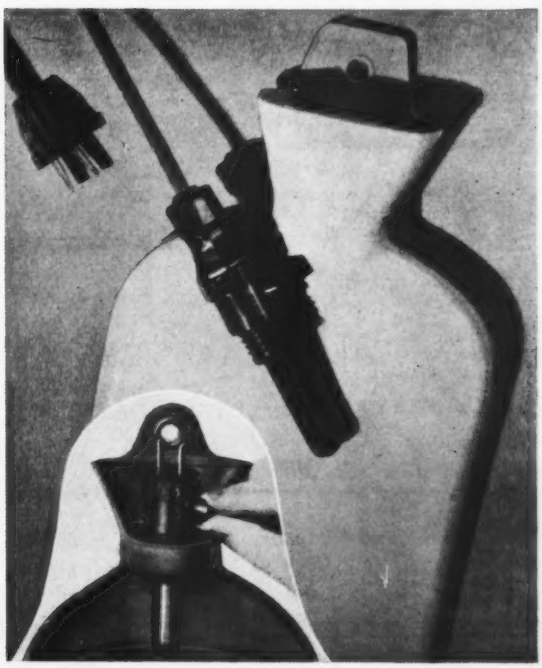
Hot-water Bottles

Some intelligent person, probably very conversant with the eternal worries and labours in hospitals and of clammy discomfort on winter nights and mornings in the home, has decided that the constantly hot-water bottle and the hot-water bottle that can be reheated by the pressing of a switch, is a sound proposition. So do we.

Thermo Electric Products Co. of U.S.A. has manufactured a Tepco heating unit which can be fitted into a rubber bottle. You can fill the bottle, set the temperature to any one of four different degrees and forget it, secure in the knowledge that it will remain constant for a great many hours—as long as the water is in contact with the unit. As soon as the water and unit are not in contact the heating element automatically ceases to function.

A special Durez moulding compound is used for the Tepco unit. This material has very low water absorption properties. It's self-insulating; won't corrode; is especially light in weight, which is a decided advantage for this application; is easily moulded in the shape to insure simplified but positive assembly.

Some of the other advantages claimed are: the unit prevents frequent disturbing of patients to refill the bottle, prevents frequent changing of wet dressings because it delivers a humid heat while there are no uneven temperatures, electric shocks or burns.



PRODUCTION NEWS

Raw Materials, New Plant, Works Organization, Control Apparatus, Research, Personal and Trade Notes

MACHINERY, PLANT AND APPLIANCES.—Under the Machinery, Plant and Appliances (Control) (No. 4) Order, 1941 (S.R. and O. 1941 No. 1,063, price 1d.), just published, new classes of machinery, plant and appliances subject to licence by the Board of Trade are added to those listed in the Schedules to previous Orders, and certain of the classes already included are amended.

Further, it has been laid down that machinery, plant and appliances may be supplied without licence under the Orders to a public utility undertaking when such supply can be made only with the licence or under the authority of a Government Department.

The complete Schedules are listed in the Order above referred to and in the Machinery and Plant (Control) (No. 2) Order 1940 (S.R. and O. 1940 No. 1363), the Machinery, Plant and Appliances (Control) Order 1940 (S.R. and O. 1940 No. 2179) and the Machinery, Plant and Appliances (Control) (No. 3) Order 1941 (S.R. and O. 1941 No. 778), each obtainable, price 1d., from H.M. Stationery Office or any bookseller.

"ROCKITE" BOOKLET.—Most moulders will have already received this valuable publication sent out last November by F. A. Hughes and Co., Ltd. We have now received a letter from this concern regarding recent additions to the "Rockite'" group of resins. It encloses data sheets covering: Inert Grade No. 3,559 and Low Loss Grades 3,790 and 3,900. It also contains a data sheet for the Heat Resisting Grade 1,329, which was not included in the original booklet, and a sheet covering High Dielectric (Air Ministry approved) Grade 3,302, which has now superseded Grade 3303.

BRITISH STANDARD FOR CAPACITORS FOR RADIO RECEIVERS.—Some time ago the Radio Manufacturers' Association prepared two specifications for capacitors, one dealing with the rating and dimensions of paper and electrolytic capacitors and the other with the colour coding of capacitors. These two specifications have now been combined into a single document and published by the British Standards Institution as War Emergency British Standard 271-1941. This is, in effect, a revision of the specification issued in 1926 for Fixed Capacitors for Radio Reception Purposes, and its object is to provide a limited range of sizes and types of condensers to be manufactured in war-time. It is considered that this restricted range will meet all the normal requirements of the industry under war-time conditions.

Copies of this revision (No. 271-1941) may be obtained from the British Standards Institution, 28, Victoria Street, London, S.W.1, price 2s. 3d. post free.

PRECISION TOOL GRINDER.—Hannifin Manufacturing Co., of Chicago, U.S.A., represented by the Broadway Engineering Co., Ltd., of Hendon, Carlisle Road, London, announces the development of the No. 5 Universal precision tool grinder for the accurate grinding of modern cutting tools, and for other precision-grinding operations. This tool grinder is designed to be a combination of a high-grade grinder and a precision-measuring instrument, with provision for simple and accurate handling of a variety of operations.

The grinding-wheel spindle is a precision unit adapted to either dry or wet grinding. It is mounted in pre-loaded ball bearings with provision for proper lubrication and for protection of the bearings from grit and coolant. The spindle is driven by a balanced heavy-duty ¾ h.p. motor, with built-in air filter and forced ventilation system. Precision ball bearings are used in this motor. The drive is through herring-bone weave belt and interchangeable pulleys, which provide for ten spindle speeds ranging from 3,600 to 35,000 r.p.m. under load. A coolant pump is provided and driven by a separate 1/15 h.p. motor.

The table has a working surface of 9 ins. by 13 ins., and is fitted with three tee slots for mounting of attachments and special fixtures.

The spindle carriage and table slides are manually operated, with both rapid rack feed and micrometer feed. Hardened and ground precision lead screws permit accurate setting of the slides and carriage. The fine-pitch lead screws are equipped with large-diameter dials which allow accurate settings. The provisions of the No. 5 precision tool grinder for exceptionally accurate measure and precision grinding make possible an extremely wide range of work, including the economical grinding of intricate forms after hardening and the accurate forming and finishing of tungsten carbide tools. A full range of fixtures is available, each designed particularly for use with the No. 5 tool grinder.

SUNVIC ENERGY REGULATOR.—We have received from Sunvic Controls, Ltd., an interesting pamphlet dealing with this energy regulator, which is already widely used.

The possibility of enemy action affecting gas supplies has focused attention on electrical heating of platens. It is not always convenient to fit thermostatic controls and resistance control is wasteful. The Sunvic energy regulator presents a solution; it gives infinitely variable control of input independent of voltage fluctuations, without the losses inevitably associated with variable resistances.

The regulator has been developed to replace the wasteful and inconvenient variable resistance as a means of obtaining adjustable power input to electric furnaces and to other industrial and laboratory heating processes. Its uses may be summarized as follow:—

1. For apparatus in which it is inconvenient or impossible to fit any type of thermostat.

2. For small high-temperature ovens or furnaces for which the cost of temperature control equipment is excessive.

3. For any heating process requiring a constant power input.

4. To reduce the rate of change of temperature and thus increase the accuracy of any existing temperature controller.

SCREW THREADS IN PLASTICS

THERE was noted in a concluding paragraph of the previous section of this article ("Plastics," July, page 146) the better surface finish obtained by first turning off the skin of moulded components before attempting to cut a thread upon them.

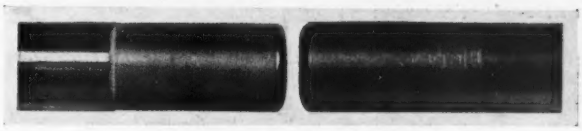


Fig. 29.—Specimens showing effect of threading after removal of skin (left), and without preliminary skinning. The superior finish obtained by the former method is very evident.

In This, the Concluding Section of the Account, Attention is Devoted to Thread-production by Chasing and to the Use of Self-tapping Screws

Table 4.—Hole Sizes for Parker-Kalon Type "Z" Hardened Self-tapping Screws.

Screw diam., No.	In plastics (phenol resins), etc.		In ebonite, slate, asbestos, etc.	
	Hole diam., in.	Drill size, No.	Hole diam., in.	Drill size, No.
2	0.078	47	0.076	48
4	0.099	39	0.101	38
6	0.128	30	0.120	31
7	0.136	29	0.136	29
8	0.149	25	0.147	26
10	0.177	16	0.166	19
12	0.199	8	0.196	9
14	0.234	15/64 in.	0.228	1

Table 6.—Hole Sizes for Parker-Kalon Type "U" Hardened Metallic Hammer-drive Screws.

Screw diam., No.	Hole diam., in.	Drill size, No.
00	.052	55
0	.067	51
2	.086	44
4	.104	37
6	.120	31
7	.136	29
8	.144	27
10	.161	20
12	.191	11
14	.221	2

Table 5.—Sizes and Holes for Self-tapping Screws according to Fig. 39.

Screw size, No.	2	4	6	7	8	10	12	14
External diam.:								
mm.	2.1	2.8	3.4	3.8	4.1	4.7	5.4	6.1
in.	0.083	0.11	0.134	0.15	0.161	0.185	0.213	0.236
Hole diam.:								
mm.	2.0	2.6	3.0	3.4	3.6	4.2	4.9	5.6
in.	0.0787	0.102	0.118	0.134	0.142	0.165	0.193	0.22

In Fig. 29, the right-hand portion of the illustration is of a $1\frac{9}{16}$-in. dia. shaft, the thread on which was cut through the skin; in the case of the bar at the left, the skin was removed by turning prior to threading, the thread itself being afterwards cut on the lathe; a perfect finish has resulted. The usual clearance angle for thread-cutting tools is 6-7 degrees, a figure as high as 10 degrees sometimes being used. For fibre, clearance angles of 25-30 degrees are recommended.

The rake angle of form tools is usually made zero in order to avoid angular deformation of the tool edge. However, the clearance angle must be considered when providing the radius. It frequently happens when designing tools for plastics that unfavourable cutting angles result and tools with abnormal rake angles must be used. Hence the tool edge must necessarily include a larger or smaller profile angle than that which it is required to generate. The radius at the tool point will, in such cases, be deformed to a part of an ellipse.

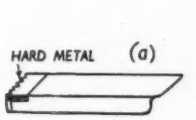


Fig. 30.—Hard-metal-tipped multi-point chaser. Tools of this type are widely used for thread cutting on plastics.

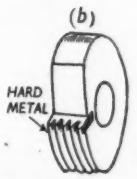


Fig. 31.—Circular-type chaser. This form possesses many advantages over that shown in Fig. 30. It may be tipped with hard-metal.

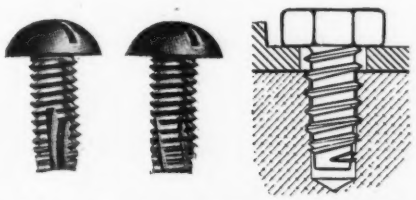


Fig. 32. — Representative types of self-tapping screws (first three at left), and a typical hammer-drive screw. The thread on the last is usually case-hardened.

Fig. 30 shows a multi-point chaser provided with a hard-metal-tipped edge. Tools of this type have been specially introduced for the threading of plastics. Occasionally hand chasers are used.

The circular-type tool shown in Fig. 31 is very popular. Its production involves no special difficulties, in so far as only a few screw profiles have to be machined, and the possibility of periodic errors, such as might occur in taps, does not arise. Where, as is recommended, a hard-metal profile is provided, it must be lapped true to form with diamond powder.

For the generation of threads on moulded and laminated plastics, milling either internally or externally may occasionally be recommended. For short thread lengths, a multi-ribbed milling cutter is used, whilst for long threads a single-profile cutter is employed and fed along the workpiece by a lead screw. In this way very clean precision threads may be generated rapidly, and the possibility of damage to the workpiece is reduced to a minimum, in so far as no great pressure need be exerted upon it.

Self-tapping screws have been in existence for a great number of years, and it is no exaggeration to say that fresh types are continually being evolved. Two principal types exist, the first comprising those which are screwed in or out by means of a screwdriver and can be loosened or tightened up at will, and those which are hammered in and normally cannot be removed.

Screws comprised under the first head, in spite of the fact that their thread form differs considerably from that of standard screws, do not exhibit marked differences in strength from screws of the usual type, and, as no tapping operations are required, their use is strongly to be recommended.

Hammer screws usually possess a pitch which gives them no self-locking powers. This disadvantage, however,

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is usually overcome by the special thread profile, which is of such a form as to provide a strong, permanent fastening in relatively soft materials. Instead of hammering the screws home, they may be pressed in automatically, either singly or several at a time; a pilot point ensures the straight driving of such screws. Table 6 gives the sizes and corresponding hole diameters to be used.

For a number of special purposes both screws and nuts are produced entirely in plastic materials, either of the ordinary laminated fabric type, or in laminated wood. The mechanical properties of the material in such cases are broadly the same as those demanded in the case of similar materials for gears and other components, and, for perfect results, machining conditions must be stringently supervised.

Naturally, the direction of the thread must be carefully chosen in relationship to the direction of the laminations; with certain types of plastic, difficulties may be caused by chipping of thread. This is to be overcome by adjustment of machining speed, feed, and depth of cut.

Avoiding Heading

If trouble be anticipated in the formation of bolts with normal hexagon heads, it may prove expedient to use stud bolts with nut and counter nut. This practice is, in any case, more economical. Nuts and bolts of this type are finding wide employment in the electrical and chemical industries where their introduction virtually created the possibility of a new system of designing.

Older methods necessitated the use either of heavy and expensive corrosion-resisting metals, or of steel or bronze bolts suitably insulated by porcelain or other non-metallic sheathing.

No attempt has been made in this account to cover every aspect of the theory and practice of threading of plastic materials. Nevertheless, it is hoped that sufficient suggestions have been made, and guidance given, to enable costly errors to be avoided and to further progress.

War and the Synthetic Resin Industry

By Harold J. Phelps, M.A., D.Phil.*
Senior Specialist, Ministry of Economic Warfare.

THE use of synthetic substitutes for natural fabricating materials is determined fundamentally by one of three economic considerations. First the desire to find an outlet for the by-products of a basic industry; secondly, the demands of the doctrines of " self-sufficiency " economics as practised by the totalitarian states, as a result of which synthetics may be substituted for imported natural materials, even when the true cost is much higher than that of the natural material; thirdly, in certain applications chemical invention has produced substances which are actually superior to the natural products they replace and may even fulfil a function for which no natural material has been found suitable. It is, of course, clear that the first and second considerations cited above are closely related, it being the obvious dual policy of a totalitarian government to discover uses for surplus by-products in the interests of industrial efficiency and to exploit the applications of the synthetics produced in the interests of economic self-sufficiency.

The economic development of the tar-acid resins illustrates the industrial history of a typical synthetic resin particularly well. These " bakelite " resins were the earliest synthetics to be exploited on a commercial scale (the nitrocellulose plastics are strictly " altered natural " products and are not properly to be classified with true " plastics " in the industrial sense) and their development has been influenced by two major wars and by the entry of the totalitarian idea into the world politics, since Baekeland registered his epoch-making patents on December 7, 1909.

During the life of the basic patents (i.e., until 1926) the production of bakelite resins increased very steadily as ever-widening fields of application were found for them. During this phase of the development of the tar-acid resins, however, their relation to the coking industry was that of a convenient user of surplus by-products. In the ten years after 1927, when the manufacture of tar-acid resins became free to all, world production increased sixteen fold. The introduction of laminated materials bonded by tar-acid resins has provided a new constructional medium which can be substituted for natural materials and even for metals in many applications. Motorcar bodies and even airframes of laminated plastics are now within sight of serious commercial development.

In Germany the development of all applications of tar-acid resins has been very rapid and particular attention has been paid to laminated plastics. As a result it may be estimated that, immediately before the war, Germany was making about 38,500 tons of tar-acid plastics annually, the distribution among the various applications being approximately as follows:—

Moulding powders	15,600 m. tons
Laminated materials	9,600 m. tons
Surface coatings	9,600 m. tons
Cast resin for machining	2,300 m. tons
Miscellaneous	1,500 m. tons
	38,600

These figures are the gross weights of resins as used by the moulders or makers of laminated materials and include fillers, lubricants and the like. Having regard to the distribution among different users indicated by the above table, it may be calculated that equivalent output of net resin was about 20,000 tons a year, and since the various applications demand by preference different types of tar-acid resins, it may be deduced that the different tar by-products were used in the following proportions:—

Phenolic resins	60 per cent.
Phenol-cresol mixtures	17 per cent.
Cresol-cresylic acid mixtures ...	19 per cent.
Cresol-xylenol mixtures	4 per cent.

This required an annual consumption of 11,500 tons of phenol, 3,800 tons of cresol, 1,200 tons of cresylic acid and 300 tons of xylenol.

As a result of its great expansion the tar-acid resin industry in Germany was thus transformed from a consumer of by-products in the coking industry into the major consumer of tar-acids. So far, indeed, had the change proceeded that the maximum recovery of coke oven by-products was enforced by law, even to the extent of subjecting the entire waters on the River Emscher to extraction with benzole to recover the phenol which had entered the river in waste liquors from gas works and coking plants. Latterly it had even been found economic to make synthetic phenol to satisfy the ever-increasing demands of the plastics industry.

It should be pointed out that although there is no doubt that the extraordinary development of the tar-acid resin industry in Germany has been promoted, above all, by the economic policy pursued by the Nazi Government, these resins have proved themselves so valuable in many applications in which they are either better or cheaper than any available natural material that the production of synthetic phenol has also commenced in the United States and will probably be introduced in other countries also to provide the very great demands of the plastics manufacturers.

* " Chemical Products," May, 1941.